CHAPTER 6: Pollution Prevention

Most of us are familiar with the old adages: "waste not, want not;" "one person's trash is another person's treasure;" and "an ounce of prevention is worth a pound of cure." By embracing the wisdom behind these three adages, pollution prevention (P2) encourages businesses to identify and act upon opportunities that benefit their operations, as well as workers, communities, and the environment.

This chapter briefly discusses the benefits, tools, and opportunities common to the P2 approach. It also summarizes pollution prevention assistance and incentive programs offered by the Michigan Department of Environmental Quality (MDEQ), Environmental Science and Services Division (ESSD).

6.1 What is Pollution Prevention?

Parts 143 and 145 of the Michigan Natural Resources and Environmental Protection Act, Public Act 451 of 1994, as amended (Act 451), define P2 as preventing or minimizing waste generation, or the environmentally sound reuse or recycling of those wastes that cannot be prevented. In Michigan, P2 is based on voluntary, multi-media efforts that are applied where practicable, environmentally acceptable, and economically feasible. Only after P2 has been applied or considered should alternative waste treatment, release, or disposal technologies be used in accordance with Michigan regulations. Common examples of P2 include:

- Replacing hazardous organic solvents with nontoxic aqueous cleaners;
- Purchasing paper stock with preconsumer and post consumer waste;
- Avoiding overstock of time-sensitive materials;
- Minimizing the use of packaging materials for printed products delivered to the customer;
- Reusing treated wastewater as process water;
- Recycling metals, solvents, oils, cardboard, wood pallets, and office paper;
- Replacing standard motors, pumps, and lighting with high efficiency models; and
- Stopping leaks, drips, and spills; and instituting preventative maintenance practices.

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Pollution Prevention vs. Pollution Control		
Type of Pollution	***Pollution Control***	***Pollution Prevention***
Silver-bearing effluent (spent fixer)	Silver reclamation	Use a silverless process
Emissions from using alcohol in the fountain	Use vapor recovery equipment	Operate with a low VOC alcohol substitute
Paper/negative waste	Recycle wastes	Use direct to plate technologies

6.2 Why Practice Pollution Prevention?

P2 is about increasing operational efficiencies, reducing risks, and effectively meeting environmental responsibilities. Unlike most pollution control strategies, P2 offers important economic, regulatory, environmental, and social benefits that can often result in a more competitive business. A facility that commits to an effective, ongoing P2 program that is dedicated to eliminating, reducing, or reusing wastes, can often:

- Reduce waste treatment, transport, and disposal costs;
- Reduce costs for energy, water, and raw materials;
- Minimize compliance issues and costs associated with regulated wastes;
- Reduce future liability through reduced risks to workers, communities, and the environment;
- Avoid costs of accidents and spills;
- Improve production times; and
- Enhance its public image and community relations. Sell yourself as an environmentally aware printer. Sales/marketing staffs are in a unique position at the front line working with customers, specifically the customer's print buyer, where there is the opportunity to influence the project requirements in a way that benefits the environment and reduces waste. Positioning your company as an environmentally aware supplier can be an important competitive advantage. Train sales and customer service workers to ask questions such as:
- Can the job be printed with recycled inks, low VOC inks, or existing ink inventory? If so, consider offering a discount to customers who use recycled inks or existing open inventory inks.

- Can the job be designed to use less paper (two-sided, bleeds, single-spacing)?
- Can the job be printed on recylced paper?
- Can the job avoid glossiness or coatings that make recycling difficult?

6.3 Getting Started

An excellent way to get started with any P2 effort is to draw upon the many resources available through MDEQ's P2 assistance programs, projects, and initiatives. To help you develop an action plan or start a P2 program, the following is a brief description of ESSD's assistance activities, field operations, and incentive programs, including industry partnerships.

For additional information on any of the P2 assistance activities, please contact the Environmental Assistance Center at 800-662-9278, or at www.michigan.gov/deq.

i) **P2 Technical Assistance:** The ESSD currently focuses on providing P2 information and technical assistance to all companies, institutions, and communities and has partnerships with specific industry sectors to promote P2 strategies.

a) **Retired Engineer Technical Assistance Program (RETAP):** Retired professionals provide on-site P2 assistance to businesses with less than 500 employees. Assessments are confidential, free of charge, and nonregulatory. There is no obligation to implement the recommendations given.

MICHIGAN RETAP
RETIRED ENGINEER
TECHNICAL ASSISTANCE PROGRAM

b) **Technical Assistance:** Technical assistance engineers answer P2 questions. They research new and innovative technologies and develop fact sheets and case studies that describe successful P2 approaches. Limited P2 technology demonstration projects and student internships are additionally provided to encourage the diffusion of P2 practices within industry.

c) **Recycling Assistance:** Staff assist companies in their recycling efforts using such tools as the *"Michigan Recycled Materials Market Directory," "Recycled Products Directory,"* and Michigan Materials Exchange Service.

d) **Pollution Prevention Technical Assistance Providers Network P2TAPN):** This is a network of nonprofit agencies and organizations that offer P2 assistance to businesses, agencies, and the public. It provides a single point of access to P2 resources in Michigan.

ii) **Field Operations:** Field staff are located in district offices throughout the state to offer environmental assistance at the local level that promotes P2 and environmental incentive programs.

iii) **Incentive Programs:** By participating in any of the following incentive programs, a business can receive well-deserved public recognition, customized assistance, and other benefits for P2 efforts.

a) **Agricultural Pollution Prevention Project:** This is a collaborative effort between the agricultural industry, independent farms, the MDEQ, and the Michigan Department of Agriculture to encourage agricultural facilities to undertake voluntary P2 efforts.

b) **Clean Corporate Citizen (C3) Program:** Regulated companies, municipalities, and institutions meeting certain environmental performance criteria can be designated as Clean Corporate Citizens. In return they receive positive public recognition and are entitled to certain regulatory benefits, such as streamlined permit processing.

c) **The Department of Defense/State of Michigan Pollution Prevention Alliance:** Participating military installations work with the MDEQ and other environmental agencies on P2 strategies to reduce pollution sources and waste in their daily operations.

d) **Eco-Friendly Boating/Clean Marina Program:** Aims to increase awareness and promote use of marina and boating best management practices to help alleviate pollution impacting Michigan's waterways.

e) **Energy Star Buildings and Green Lights Programs:** These two energy efficiency programs are open to all organizations and promote the use of profitable, energy-efficient technologies as a way to increase profits and prevent pollution.

f) **Environmentally Preferred Purchasing Partnership:** A Memorandum of Understanding between the Michigan Department of Management and Budget and the MDEQ created a statewide purchasing partnership to increase the use of environmentally preferred products in state government.

g) **Food Industry Pollution Prevention:** Commercial and institutional food-related facilities can save money and protect the environment by reducing waste and practicing P2.

h) **Lake Superior Pollution Prevention:** This program is working toward the goal of zero discharge and emissions of toxic substances entering Lake Superior.

i) **Local Health Department Partnership:** A partnership between the Michigan Association for Local Public Health and the MDEQ to create and strengthen existing voluntary and cooperative approaches to preventing pollution throughout the regulated community and the general public.

j) **Mercury Pollution Prevention:** Mercury is a persistent, toxic, bioaccumulative chemical that should never be improperly handled or disposed. ESSD staff provide information on use reduction, proper cleanup, and disposal of mercury.

k) **Metal Finishing Pollution Prevention Initiative:** This is a voluntary initiative among the Michigan metal finishing industry, related trade associations, and municipalities that enhances the coordination and delivery of P2 services to metal finishers in the state.

l) **Michigan Auto Project:** DaimlerChrysler, Ford, and General Motors incorporate P2 throughout their business operations, products, and practices. The project focuses on reducing the use, generation, and release of persistent toxic substances and other materials of concern.

m) **Michigan Business Pollution Prevention Partnership (MBP3):** Open to all businesses, associations, organizations, and agencies, MBP3 is a voluntary P2 program designed to encourage businesses to initiate or expand their P2 practices. Participants receive well-deserved public recognition for their efforts.

n) **Michigan Great Printers Project (MI-GPP):** A regional collaboration within the lithographic printing industry that promotes P2 as the standard operating practice.

o) **Michigan Pulp and Paper Pollution Prevention Program (P5):** This voluntary program encourages P2 activities at pulp and paper mills in Michigan. Participating mills adopt P2 policies, establish goals, then track and report on their progress annually.

p) **Michigan Turfgrass Environmental Stewardship Program:** Targeted to Michigan's golf industry, this program is designed to advance P2 and environmental stewardship within the industry and recognize resulting environmental achievements.

q) **Small Business Chemical Manufacturers' Pollution Prevention Initiative:** A voluntary initiative among the Michigan chemical manufacturing industry that enhances the coordination and delivery of P2 technical assistance services to the chemical manufacturers in the state.

iv) **Small Business Pollution Prevention Loan Program:** Low-interest loans of up to $100,000 are available to small businesses of 100 employees or less to finance projects that eliminate or minimize the generation of waste through P2 or result in the identification of significant energy savings within their organizations.

v) **Education and Outreach:** Educational opportunities through workshops, seminars, and conferences are regularly provided through partnerships with businesses, trade associations, and other groups. These events disseminate information on P2, new technologies, current regulatory requirements, and compliance assistance. The ESSD also publishes newsletters, bulletins, fact sheets, and case studies and distributes many other P2-related documents. A list of these publications is available on the MDEQ web site at **www.michigan.gov/deq**.

6.4 The Pollution Prevention Plan

15 Steps to an Effective Pollution Prevention Plan	
STEP 1	Get management's commitment and support.
STEP 2	Develop a company pollution prevention policy statement.
STEP 3	Gain ongoing, company-wide commitment.
STEP 4	Establish a pollution prevention team.
STEP 5	Select a pollution prevention coordinator.
STEP 6	Establish overall waste reduction goals.
STEP 7	Establish priorities and procedures for conducting detailed assessments.
STEP 8	Designate a detailed assessment team.
STEP 9	Conduct the waste assessment.
STEP 10	Identify potential pollution prevention opportunities.
STEP 11	Perform technical and economic analyses on potential P2 opportunities.
STEP 12	Develop an implementation plan.
STEP 13	Implement the selected projects.
STEP 14	Evaluate project effectiveness and document results.
STEP 15	Modify and build on your pollution prevention plan.

It has been shown that a systematic approach to planning, with measurable goals, results in effective P2. A well-designed P2 plan is considerably more effective in reducing waste by ensuring that P2 projects are technically viable and financially effective. A good plan includes gaining full support of management, committing resources, and establishing policies that support waste reduction within the company. Talent throughout your business should be called upon to contribute P2 ideas, technical assistance, and decision-making. By following the steps outlined below, you can set the stage for a successful P2 program.

☑ *Step 1: Get Management's Commitment and Support*

A P2 program will only be as strong and effective as the company's internal commitment. Thus, the first and most important step is making the philosophy of waste prevention and reduction a company priority. P2 should be incorporated into every aspect of the business, including mission and policy statements, budgeting, purchasing, design, and production. A high level manager should announce the program to employees, ask for their input in identifying areas where waste can be reduced, and seek their participation in carrying out all P2 projects.

☑ *Step 2: Develop a Company P2 Policy Statement*

Putting the company's commitment in writing helps to legitimize the program with all employees and can lead to an attitude change that makes P2 "an everyday part of doing business."

☑ *Step 3: Gain Ongoing, Company-Wide Commitment*

Some companies have initiated bonuses or award programs for employees who make significant contributions to P2 programs. Others find that employees derive satisfaction from being actively involved in decisions that affect their production and work-related activities.

☑ *Step 4: Establish a P2 Team*

Once your facility establishes a clear commitment to P2, gather interested, appointed, and affected individuals for a brainstorming session (see Step 10). This group of individuals should include a cross-section from all levels of staff, including management to front-line workers in the purchasing, financial, clerical, production, and warehousing areas.

☑ *Step 5: Select a P2 Coordinator*

Heading the P2 team should be a P2 Coordinator. This P2 champion is the one who facilitates the assessments, carries forward your team recommendations and provides oversight to the implementation of projects. This person also acts as a point person for any questions, comments, or recommendations from other employees. Putting someone in charge helps ensure that the program will move forward in a timely and effective manner.

☑ *Step 6: Establish Overall Waste Reduction Goals*

It helps to aim for a target goal (such as achieving specific reductions or eliminating hazardous waste by a set date) when establishing program parameters and activities. Then ask what steps the company needs to take to achieve this goal.

☑ *Step 7: Establish Priorities and Procedures for Conducting More Detailed Assessments*

Before conducting a waste assessment, you must determine how waste will be measured, how costs will be assessed, and how the assessment will proceed. Identify potential obstacles and define the means for overcoming them. These obstacles will be less likely to impede the process if there is a mechanism for addressing them as they arise.

☑ *Step 8: Designate a Detailed Assessment Team(s)*

Designate a team to perform detailed waste assessments (or an individual if staffing is tight). This team should explore waste from various sources (e.g., imaging, binding, printing) and various types of waste (e.g., inks, cleaning materials, paper, glue).

☑ *Step 9: The Waste Assessment: Identify, Quantify, and Assign a Cost to Waste Streams*

An in-depth, comprehensive waste assessment is critical to a successful P2 plan. Experience has shown that only after a company realizes the true costs of its wastes will it have the motivation needed for an ambitious P2 effort. Also, by assigning waste costs to specific department budgets, greater efforts to eliminate costs associated with waste are likely to occur. An in-depth waste assessment helps a business to identify:

- Sources, compositions, and the true costs of wastes.
- Potential P2 opportunities and the benefits of acting on these opportunities.
- Obstacles to implementing P2 opportunities.

For a very small business, an in-house waste assessment might consist of a visual inspection of what goes into the trash dumpster, followed by research into local opportunities for recycling cardboard, office paper, plastic packaging, and other easy-to-recycle materials. Businesses with more complex operations should perform a walking tour of the facility observing the various points of waste generation and the conditions having the potential for causing accidents, health hazards, or environmental emissions. Discussions with operational staff typically reveal additional useful information. Other sources of important information include records of waste disposal costs, environmental compliance documents, and raw materials purchase invoices.

Additionally, a business can request a RETAP assessment that identifies P2 opportunities within the facility. If you are a business desiring free, confidential, RETAP assessment, contact the Environmental Assistance Center at 800-662-9278 and ask to speak to the RETAP coordinator. Businesses may also wish to have an assessment conducted by a professional technical consultant for characterizing wastes, as well as performing a cost-benefit analysis of each P2 option.

☑ *Step 10: Identify Potential P2 Opportunities*

Once the information is collected and presented, team members should discuss possible alternatives to waste-producing processes and/or ways to reduce/recycle waste streams. An initial list of P2 opportunities can typically be developed with simple brainstorming. However, the

team should look for examples in the literature and from other companies. The team should also contact outside sources for technical assistance or additional ideas.

Following are some questions the team can raise to stimulate discussion of alternatives:

- What is the direct cause of a hazardous release?
- What can be done to prevent the release or reduce its volume?
- Can any hazardous products be replaced by nonhazardous alternatives?
- What are the frequency, methods, and needs for cleaning the equipment?
- Can solvents used in the production process be recaptured or recycled?
- Can operation functions be accomplished by different methods?
- Do print suppliers accept used containers for recycling or reuse?
- Can the toxicity of the products be reduced?
- What materials can be replaced by recyclable materials?
- What are options for on-site and off-site waste treatment?
- What materials (such as waste paper, scrap film) can be recycled?

☑ *Step 11: Perform Technical and Economic Analyses on Potential P2 Opportunities*

Based on a set of selection criteria, an examination of the technical workability of P2 opportunities should occur, followed by an evaluation of cost and environmental impacts of each opportunity. This requires consideration of all costs and benefits involved, such as decreases in operating costs; changes in regulatory burden; future liabilities; and improvements in productivity, worker safety, environmental protection, and quality management practices.

Potential Benefits of Pollution Prevention Practices

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Decreased waste management costs:
Means: Bottom line savings

Decreased environmental compliance costs:
Means: Less time spent assuring compliance

Decreased future environmental liability:
Means: Decreased likelihood of site cleanup
Increased future property values

Increased efficiency and productivity:
Means: On-time delivery and quality work

Increased worker safety:
Means: Decreased workers compensation claims, sick time
Increased productivity

The P2 Team should investigate possible funding sources for those projects that require capital investment. A financial analysis of any project is helpful in requesting funding. Members of the financial departments should be included in this process. Options with the highest rate of return should be presented to management as final recommendations.

☑ *Step 12: Develop an Implementation Plan*

With management's decision to act upon given P2 opportunities, steps to create waste reduction actions must be designed. Financial and personnel resources must also be designated. An excellent financial resource, open to small businesses of 100 employees or less, for financing their P2 projects is low-interest loans of up to $100,000, available from the Small Business Pollution Prevention Loan Program.

For additional information on the loan program, contact the Environmental Assistance Center at 800-662-9278 and ask to speak to the Small Business P2 Loan Program Manager.

It is important that each step of the implementation plan be approved by the P2 team. For each step or action to be taken, clearly indicate the following:

- Action to be implemented;
- Person or persons responsible for implementation;
- Possible barriers and ways for overcoming them; and
- Time for action to be completed.

Role Involvement Examples in a P2 Implementation Plan

MANAGEMENT	P2 HAZARD REDUCTION TEAM
•Publish (goals, objectives, targets, tasks) •Authorize Budget •Assign Tasks •Track Costs and Benefits •Provide Recognition/Rewards	•Detailed Assessment •Task Assignments •Coordinating/Monitoring/Facilitating •Execute Assignments •Review •Report
PURCHASING	**PRODUCTION/MANAGEMENT**
•Revise Material Ordering System •Revise Material Sourcing (look for vendors w/environmental options) •Revise Order Quantities •Revise Packaging Specifications	•Revise Operations Procedure •Provide Training •Provide Motivation
ENGINEERING	
•Specify Improvements •Design Changes to Facilities •Oversee Changes	

☑ *Step 13: Implement the Selected Projects*

Inform all employees about the selected P2 projects and begin the implementation phase. All involved employees should have a clear understanding of the purpose of the P2 project and their role in implementing it. The P2 team members should lead other employees and provide guidance in the implementation process.

☑ *Step 14: Evaluate Project Effectiveness and Document Results*

By reviewing the program's successes and failures, managers can assess the degree to which P2 goals are being met and what the economic results have been. The comparison identifies P2 techniques that work well and those that do not. This information helps guide future P2 assessment and implementation cycles.

In order to evaluate project effectiveness, a set of baseline data (gathered during the waste assessment phase) should be used to measure progress. Periodically conduct tests to determine if and where waste and hazards have been reduced. Results should be documented. This is a good way to determine if alternative production methods are working as expected. It is also an opportunity to reevaluate methods and make any corrections.

☑ *Step 15: Modify and Build on Your P2 Plan*

The P2 plan should evolve as the P2 program proceeds. Goals once achieved can be expanded, and policies can be added to target materials still remaining in the waste stream. Maintaining a viable P2 program requires continued support and involvement from management and constant effort from everyone involved in planning and implementation. With continued support and enthusiasm from respected persons within the company, employees at all levels can implement sound P2 projects. P2 can become a part of quality management practices, contributing to the company bottom line.

6.5 Pollution Prevention Opportunities and Techniques

6.5.1 Common/General Practices

There are typical ways to increase efficiency and prevent waste in all aspects of a business. The following is a brief review of some of the most common P2 opportunities and techniques a business can use to achieve their P2 goals. For additional ideas or more in-depth information, contact the ESSD at 800-662-9278, and they will be happy to assist you.

6.5.1.a Cost Accounting

Experience has shown the most successful P2 programs are those that account for the true cost of wastes, including expenses for lost raw materials; staffing; needed paperwork and insurance; sample analyses; as well as storage, treatment, and disposal costs. Successful billing strategies to account for the true costs of wastes include the following approaches:

- Charge direct and indirect costs of all air, land, and water discharges to specific processes, products, or departments;

- Allocate treatment/disposal costs to operations/departments that generate the waste; and

- Allocate utility costs to specific processes, products, operations, or departments.

6.5.1.b Purchasing and Inventory Management

- Order products according to need. The cost associated with the disposal of surplus hazardous materials often exceeds the purchase price of the item.

- A coordinated material purchasing program can monitor all requests for products throughout the company or plant and implement efficient purchasing policies.

- An inventory control program can promote sharing of materials between common users, provide data on who is using extremely hazardous products, identify large volume users, locate unused caches of materials, and identify where waste reduction/material substitution options are viable. Inventory control should rotate stock on a first-in, first-out basis.

6.5.1.c Packaging, Shipping, and Containers

A second look at the transportation and product packaging that companies send and receive often leads to waste reduction without sacrificing product safety or quality.

- Request that deliveries be shipped in returnable/recyclable containers.

- Work with suppliers and customers to eliminate excess packaging.

- Increase your use of reusable shipping containers and recycled or recyclable packaging.

- Purchase products in bulk, in concentrated form, or in quantities matching process demand.

6.5.1.d Energy Usage and Efficiency

Energy use is often seen as a key area where, through efficiency, operating costs can be significantly and readily controlled. Energy savings can be achieved by simple changes in daily operations, maintenance practices, and worker habits, and can be implemented at little or no cost. Although more significant energy savings may involve investment in new/upgraded equipment, these simple changes typically have excellent financial returns. Basic energy efficiency steps include:

- Submeter energy usage for detailed information on how and where energy is used;

- Maintain equipment and the facility through an ongoing maintenance program:

  i) *Furnaces*
     - Analyze flue gas and adjust the fuel-air ratio to increase efficiency.

ii) *Process Heat, Heat Recovery, and Heat Containment*

- Enhance sensitivity of temperature control and cutoff.
- Use flue gas waste heat to preheat combustion air.
- Minimize material use in laminating process.
- Use jacket heaters for glue melting pots.

iii) *Process Cooling: Cooling Towers and Chillers/Refrigeration*

- Use a cooling tower instead of refrigeration when outside temperature allows.
- Use waste heat for absorption refrigeration.

iv) *Motors and Drives*

- Develop an ongoing motor replacement program to upgrade existing motors to high efficiency motors. Where power factor is not controlled elsewhere in the shop, choose replacement motors with high power factor.
- Use variable speed drives to control motor speeds.

v) *Compressed Air Systems*

- Compressed air is almost always the most expensive means for performing work at a facility and should only be used when essential.
- Establish a vigorous maintenance program and check for leaks often.
- Educate employees about the substantial energy costs related to compressed air use.

vi) *Electrical Power*

- De-energize excess transformer capacity and increase power factor for facilities and equipment by installing the proper combination of fixed and variable capacitance.

vii) *Heating, Ventilation, and Air Conditioning (HVAC) Equipment*

- Develop an optimal start/stop schedule for your HVAC system.
- Install locks on temperature- and humidity-sensing devices to prevent tampering.
- Use a seven-day, programmable thermostat to coordinate system operations with loads.
- Install variable air volume systems where practical.
- Install an airside, rooftop, central, or waterside economizer to use outside air to cool the space when outside temperatures allow.
- Close off and seal unused areas and reduce heating and cooling in little-used areas.

viii) *Lighting*

- Install low-mercury T-8 or similar triphosphor fluorescent systems with electronic ballasts.
- Remove two out of four tubes in fluorescent fixtures where lower light levels are acceptable. Also, disconnect the ballast that operates these tubes to save even more energy. If necessary, install reflectors or higher output lamps so more light is utilized.
- Install low-wattage, long-life, light-emitting, diode exit signs.
- Use high-efficiency halogen, low-voltage halogen, and quartz lamps where lighting quality is critical (e.g., retail displays).
- Replace mercury vapor or other inefficient, high-intensity, discharge lighting systems with an efficient, metal halide, sodium, or other high-output fluorescent system.
- Tailor lighting levels to the task and occupants, and increase the use of “task lighting.”
- Rewire fixtures or use dimming controls so unnecessary lighting can be turned off.
- Install occupancy sensors in areas of sporadic use.

6.5.1.e Office

- Purchase or lease copiers and printers equipped to make two-sided (duplex) documents.
- Use both sides of paper when printing and copying.
- Purchase or lease computer monitors and office machines that have energy-saving automatic shutdown features, such as products with the Energy Star label.
- Use reusable fax cover sheets or fax transmission labels.
- Use e-mail for internal memos and exchanging electronic documents.
- Keep mailing lists up-to-date to avoid duplication.
- Share materials and circulate single copies of document, newsletters, and magazines among employees.
- Use reusable interoffice envelopes.
- Maintain a central filing system to eliminate duplication, or store information electronically.
- Turn off the lights on the front of beverage and snack dispensers.
- Use reusable glasses and cups rather than disposables.

6.5.1.f Aerosol Cans

Generally, aerosol cans used for business purposes will be considered hazardous waste when it comes time to dispose of them, regardless of the prior contents. There is a waiver of their classification if they can be considered “empty” per regulation definition. If you have any question whether your aerosol can wastes are hazardous, call your district Waste and Hazardous Materials Division (WHMD) staff or refer to Chapter 2.3.2 of this guidebook. The most effective way of reducing aerosol container waste is to avoid purchasing products in aerosol form. When this is not feasible, then maximize usage of all aerosol materials.

- Instead of aerosol cans, use refillable containers that use compressed air as the propellant.
- Purchase aerosol cans according to demand so that the product’s shelf life does not expire.
- Store aerosol cans away from moisture, sunlight, and extreme heat or cold.
- Use entire contents of the aerosol can including the propellant.
- Purchase products which contain the least hazardous or environmentally detrimental materials.
- Recycle empty aerosol cans with scrap metal, if possible, or in a separate program.
- Return defective cans containing hazardous product or propellant to the manufacturer or dispose as hazardous waste.

6.5.1.g Shop Towels

Printers use solvents and wipes to clean oil-based ink from equipment. Regulatory and cost pressures, along with related worker safety and liability issues, have led to the development of numerous alternative cleaning technologies, safer solvents, and improved cleaning and recovery equipment. Implementing safer cleaning technologies often requires:

- A better understanding of the chemistry, mechanics, and other fundamentals of cleaning;
- A clear determination on how clean equipment or process materials truly need to be;
- A review of upstream processes/practices and how they influence the cleaning process;
- An awareness and understanding of the pros and cons of potential alternatives;
- Some degree of modification of both up- and down-stream processes and practices; and
- A significant experimentation and learning period for identifying appropriate and effective alternative cleaners, optimizing cleaner concentrations and cleaning times, adjusting equipment and process operations, and modifying employee practices.

In general, pollution prevention opportunities for solvent cleaning processes include:

- Proper management of cleanup wipes
  Leased fabric towels or disposable wipes are typically used for cleaning presses. Either type of wipe can become an environmental hazard, and expose printers to expensive environmental cleanup costs, if not managed properly.

  i) *Leased Towels*
  Leased fabric towels are typically sent to an industrial laundry for cleaning. Rags contaminated with solvent are not considered hazardous wastes under federal and state regulations if they are not saturated (saturated rags can be rendered nonhazardous by wringing or centrifuging) and are laundered and reused. The residues washed from used towels at the laundry can become a concern to the local regulatory agency that oversees the sanitary system as the contaminants are washed out into the wastewater. It is the presence of these inks and solvents that create problems for the industrial laundry and the community sanitary sewer system that handles the wastewater from the laundry. Printers can be part of the solution by reducing the amount of solvents in rags sent to laundries.

  ii) *Disposable Wipes*
  Users of disposable wipes must assure the used wipes are disposed of properly to remain in compliance with regulatory requirements and minimize corporate environmental liabilities. Used wipes may be subject to hazardous waste regulations if the wipes contain solvents or residues (e.g., heavy metals such as lead and chrome) that are classified as hazardous. However, even if the wipes do not contain hazardous solvents or residues, it may not be in the best interest of the generating printer to dispose of their wipes with the rest of its trash. Contaminants that can leach out of the wipes at a landfill can expose the generator to expensive remediation costs if the landfill that is used is determined to be causing ground water contamination. If disposable wipes are used, it is important that the generators have an accurate, comprehensive picture of all of the solvents and residual contaminants that could remain on used wipes from the plant.

- Reducing solvent waste

  i) *Reduce the Need for Cleaning*
  Improve production methods by coordinating runs according to color, type or quantity, thereby reducing the number of cleanups.

  - Use standard sequence on process colors to minimize color changes for presses.
  - Run similar jobs simultaneously to reduce cleanup.
  - Clean ink fountains only when changing color; use spray skin overnight.

  ii) *Use Alternative Solvents*
  Review the types of inks used, and the solvents needed to clean presses after their use.

  - Choose a solvent that minimizes hazardous waste and air pollution. Carefully review the material safety data sheets when considering purchasing a cleaner.

- Try to avoid cleaning solutions with solvents or chemicals that would cause used cleaners to be classified as hazardous because of toxicity or flammability.

- To reduce air pollution, try to use cleaners with a low (no more than 30 percent) volatile organic compunts (VOC) content, and a low vapor pressure (less than 10 mm mercury).

- Use waterless or ultraviolet cured inks whenever possible.

iii) *Reduce Solvent Use in Cleanup*
When solvents are essential to a cleanup, alternative cleaning methods can reduce the amounts of solvents used and can result in cost savings.

- Avoid soaking cleanup wipes in solvent.

- Use pump or squeeze bottles to dampen wipes.

- Use automatic blanket washes.

- Utilize solvent sinks for cleaning parts to reduce once-used solvent cleaning of press parts.

- Use spot application of solvents for stubborn ink residues rather than general over application of solvent.

Good housekeeping practices can also reduce the amount of solvents used in cleanup. Dispensing and storage tips to reduce solvent use include:

- Cover solvents to reduce evaporation.

- Dispense solvents from a central source.

- Track usage at individual press or operator level.

- Do not allow personal supplies of cleanup solvents.

- Limit the access to disposable wipes and number of wipes available to minimize use.

iv) *Remove Excess Solvent From Wipes*
Hand wring, mechanical wring, or spin shop towels in a centrifuge to recover as much solvent as possible for recycling. Solvent recovery vendors can help you determine the appropriate equipment for your needs. Ensure that recovered solvent is stored in a closed, clearly marked container. Before installing a centrifuge, be sure to check local fire codes that may affect ventilation and electrical requirements.

v) *Collect Solvent Waste for Recycling*
Use efficient methods of collecting solvent waste while reducing the chance of spills.

- Provide clearly marked drums or containers to collect solvent waste.

- Use transfer pumps for solvent drums to minimize spillage.

- Modify drain trays as necessary to make it easy and neat to pour or drain collected solvents into storage drums.

- Add receiving funnels with automatically closing covers to storage containers to decrease spills and air pollution from evaporation.

vi) *Increase Accountability for Solvent Use*
Using an inventory control program that tracks solvent use and waste generation, and makes departments financially accountable for their waste streams. Have one person responsible for oversight of solvent storage and dispensing. Provide regular feedback to departments on waste minimization performance.

vii) *Educate Customers*
Printers can help customers understand the processes and environmental impacts associated with the use of various inks, papers, and coatings. Show customers that their choices can reduce your need to use cleanup solvents and inks with environmentally problematic constituents. Most customers want to do the right thing, when presented with affordable, environmentally-preferable choices.

- Making Waste Reduction a Success
  Employee cooperation and commitment is essential. Encourage employees to help identify waste reduction opportunities and understand the changes in procedures and equipment required to achieve waste reduction goals.

  Management commitment to a workable solution shows employees that waste reduction is a priority. Keep waste reduction programs visible and communicate goals and accomplishments regularly.

(Excerpted from: SHWEC Document #425.WP.9410. Researched and written by Kristin Andersen, Pollution Prevention Intern, under the guidance of Wayne Pferdehirt, Pollution Prevention Specialist, University of Wisconsin-Extension, Solid and Hazardous Waste Education Center (SHWEC). Revised 10/95.)

6.5.1.h Training

- Educate employees about P2 and why it is important.

- Train employees on proper filling and transfer techniques for inks and chemicals to minimize drips and spills.

- Train employees to completely empty containers prior to disposal.

- Train and encourage employees to seek other P2 opportunities.

6.5.1.i Water

Water use and wastewater discharge entail substantial costs for many printers. By metering water usage and regularly taking inventory of all water users, companies can reduce a major operating expense and reduce the demands on wastewater treatment facilities.

- Use countercurrent rinsing and equip all hoses with shut-off nozzles.
- Install automatic valves on equipment to stop water flow when not in use.
- Replace high-volume hoses with high-pressure, low-volume cleaning systems.
- Replace “once through” cooling systems with closed-loop cooling systems.
- Use filtering treatment processes to enable reuse of imaging process water.
- Identify and repair leaking toilets, faucets, and other fixtures.
- Install aerators, springloaded valves, or timers on all faucets.
- Install water-saving showerheads.
- Retrofit or replace toilet to reduce water use.

6.5.2 Pre-Press

6.5.2.a General

- Follow manufacturers’ directions when storing chemicals sensitive to temperature and light.
- Use dry positive proofs or aqueous developed proofs.
- Avoid overstock and implement first-in/first-out inventory practices.
- Use silverless films such as diazo, vesicular, photopolymer, electrostatic or selenium-based, if appropriate.
- Ask vendors for nonhazardous or less hazardous substitutes to products currently in use.
- Implement digital technologies which eliminate prepress waste even further than traditional desktop copy preparation by directly transferring a computer-generated image to the plate.
- Properly dispose of process wastes from fixers, wetting and cleaning agents, intensifiers, reducers, bleaches, light sensitive plate coatings, and scrap film.
- Use pre-sensitized lithographic plates, water-developed plates, or thermal plates.
- Implement digital proofing or soft proofing.

6.5.2.b Image Processing

Lithographic printers can take actions that will help them to recycle silver and at the same time generate less wastes during image processing. These wastes typically include film, developer, fixer, and wash waters, all of which can be harmful to the environment. Some developer solutions contain hydroquinone, which can make them a hazardous waste in Michigan. Film, fixer, and wash waters can contain silver, a regulated metal. This section describes how to manage these wastes in an environmentally sound manner, and emphasizes the importance of recovering silver from both business and environmental standpoints.

i) *Developer*

Developer solution consists of a developing agent and other chemicals such as accelerators, preservatives, and restrainers. Hydroquinone, a benzene derivative and extremely hazardous material, is often used as the developing agent. If unused developer is disposed, it has to be managed as a hazardous waste because of the hydroquinone content. On the other hand, hydroquinone is exhausted while film is being developed; therefore, used developer can typically be safely discharged to the local wastewater treatment plant with permission from the plant. Neutralization before discharge may be necessary. The following tips will help you reduce developer solution wastes:

- When hand processing, solutions should be in trays only slightly larger than the materials being processed and solution temperatures should be maintained within $1/4^{0}$F of product guidelines.
- Install floating lids.
- Keep developer solutions covered when possible to prevent oxidation and reduce emission.
- Use squeegees during hand development or install them on automatic processors (be careful not to damage film).
- Ask your chemical supplier about how to use replenishers to regenerate developer solutions. As the developing reaction takes place, the developing agent is consumed, but developer solution can be replenished to extend its life.

ii) *Fixer*

Developing action is stopped by immersing film into a fixer bath of ammonium thiosulfate, sodium hyposulfite or a sodium thiosulfate blend (hypo). During this process, undeveloped silver is removed from the film and goes into suspension in the fixer. Used fixer can contain as much as 8,000 parts per million (ppm) of silver. Use electrolytic recovery, metallic replacement, or ion exchange, separately or in a series, to remove silver from fixer solution. Silver should be removed before the fixer is disposed or discharged to a wastewater treatment plant.

To reduce the amount of fixer waste generated:

- Keep the pH of the fixing bath between 4.1 and 5.5 by adding acetic acid as necessary;

- Reuse desilvered fixer, replenish as required;

- Use an acid stop bath prior to the fixing bath to help keep the pH of the fixer low by preventing developer carryover; and

- Keep chemical containers closed to prevent oxidation and minimize emissions.

iii) *Silver*

Waste fixer and wash waters, along with film, can contain silver. If the silver is present in leachable concentrations of five ppm or more, these wastes can be classified as hazardous. Five ppm is also a common wastewater discharge limit for silver, but local wastewater treatment plants have the option of setting the discharge limit for their facility much lower (see Chapter 3 for further information). If a printer is permitted/authorized to discharge fixer solution and wash water to a wastewater treatment plant, it is important to know the discharge limit for silver and what silver recovery options exist for meeting the discharge limit. Never discharge silver-bearing wastewater to a septic system. Besides being illegal, this could cause serious contamination and create an expensive cleanup responsibility for your company.

- Silver Recovery Option

  Although silver recovery is a treatment method and not true pollution prevention, it is commonly used and important to address. Photoprocessors commonly use one or a combination of three silver recovery methods. The first two, electrolytic (electrowinning) and metallic replacement, are used to recover silver from spent fixer. The third method, ion exchange, is used to remove silver from rinse water. Ozone oxidation, reverse osmosis, and chemical precipitation are less frequently used methods of recovering silver. To confirm that a selected silver recovery option is achieving the required discharge limits, it is important to test the effluent being discharged from the print shop. Test papers or test kits should be used weekly. Once each six months, a sample should be pulled from the shop's effluent and analyzed by an environmental analytical laboratory to confirm that discharge limits are being met.

- Electrolytic Recovery Units

  In electrolytic recovery units, a direct current is applied across two electrodes which causes positively charged silver to become "plated" onto negatively charged electrodes. Electrolytic recovery is most effective on silver-rich solutions such as fixer solution. Electrolytic recovery can also be used to recirculate fixer, thus minimizing the amount of waste fixer generated; if recirculated, pH levels should be adjusted and any additional replenishment conducted.

  Electrolytic recovery units can be used as a batch recovery system, a continuous recovery system or as a recirculating recovery system. In all applications, be sure to control the current density so "sulfiding" does not occur. Sulfiding is the decomposition of

thiosulfate into sulfide at the cathode. This contaminates the deposited silver and reduces recovery efficiencies. Remember this rule of thumb, the higher the silver concentration, the higher the current density can be without sulfiding occurring. Therefore, as silver is plated out of solution, the current density needs to be reduced to prevent sulfiding.

- *Metallic Replacement*
  This method of silver recovery is based on the principle that a more chemically active metal (iron, zinc or aluminum) will replace a less chemically active metal (silver) in solution. Canisters (or buckets) containing steel wool or a mesh screen are used to trap silver when spent fixer is pumped through the unit.

  - ✔ Ensure that the flow of fixer through the canisters is slow enough for recovery of silver and that the pH is maintained between 5.0 and 5.5.
  - ✔ Use two canisters in a series. If you generate less than 0.5 gallons of fixer per day, only one canister is needed. A second canister with such low flows could oxidize and channel by the time the first canister is exhausted.
  - ✔ Install clear tubing and sample ports between canisters. Monitor the effluent weekly. Brown solution indicates that the first canister should be replaced. Monitoring can also be conducted using silver estimating test papers or a chemical test kit.
  - ✔ Track and log fixer usage to be able to predict the effective life of each canister;
  - ✔ Keep a log of any measurements taken as evidence that discharge limits are being met.
  - ✔ When changing canisters, remove the first one and put the second canister in the first position. Fill a new canister with water before installing it in position two to prevent the steel wool from prematurely dissolving.
  - ✔ Rinse free silver from canisters with clean water before sending them off-site. Treat this rinse water by discharging it through the metallic replacement system.

- *Ion Exchange*
  Ion exchange is the exchange of ions between an ion in solution and one that is bound on a large polymer molecule. In the silver recovery unit, the silver bearing solution passes through and the silver ion is exchanged for the chloride or sodium ion. The ion exchange is most effective on dilute solutions like rinse water.

One alternative to recovering silver with an on-site process is to ship your silver-containing solutions off-site to a silver recovery company. Generally, if you ship wastes off-site, you need to contract with a hauler that has a hazardous waste transportation license and follows all U.S. Department of Transportation (USDOT) hazardous transport regulations.

Comparison of Silver Recovery Technologies

Technology	Relative Cost	Advantages	Disadvantages
Fixer Treatment			
Metallic Replacement	Low	-Cost -Simple to operate -Low concentration effluent	-Low purity silver product -Fixer cannot be reused because of high iron concentration
Electrolytic Plating	Moderate to high	-Higher purity silver product -Desilvered fixer may be reused	-Cost -Complex setup & operation -Effluent requires additional treatment
Precipitation	Low	-Cost -High purity silver product	-Batch treatment -Hazardous chemicals
Off-site recycling		-Don't have to worry about properly operating silver recovery equipment	-Spent fixer must be re-cycled as a hazardous waste. Large batches generated may affect hazardous waste genera-tor category
Rinse Water Treatment			
Ion Exchange	High	-Low concentration effort	-Cost -Complex setup -Silver requires further recovery
Metallic Replacement	Low	-Cost -Low concentration effluent -Simple to operate	-Low purity silver product

iv) *Film/Film Trimmings*

Film scraps have silver on them. When film is soaked in fixer a coating of leachable fixer remains on the film. This can make the film a hazardous waste but for lithographic printing usually does not. You may be required to perform a toxicity characteristic leaching procedure (TCLP) test prior to disposal. Refer to Chapter 2 for information on disposing of hazardous waste.

Recycle your film, if possible. If the film cannot be recycled, it often can be disposed of as nonhazardous because commercial and professional films/papers usually pass a TCLP test. If in doubt, test before you discard.

Consider using silver-free film such as diazo, vesicular, photopolymer, electrostatic, or selenium-based. Consider using a “direct to plate” or “computer to plate” system. Another alternative is implementing digital proofing technologies.

v) *Wash Baths*

Wash baths remove developer and fixer residues from the film. Silver can be carried from the fixer solution into a wash bath with silver concentrations reaching as high as 200 parts per million (ppm). Use ion-exchange or metallic replacement to recover silver form wash waters. There are pros and cons to each type of system in this application. Determine which is best for your process.

To reduce the amount of wash water generated:

- Replace parallel wash systems with counter current wash systems (but be aware that an increase in the concentration of silver in the wash water will result, making effective recovery even more important). In counter current wash systems, rinse water is used in the initial film wash and fresh water is introduced only at the final rinse stage.
- Use rinse bath agitators.
- Recirculate the wash water by using metallic replacement or ion-exchange.
- Use automatic flow controls in place of continuous flow rinse water systems that constantly consume water whether film is being processed or not.

6.5.2.c Platemaking

The printing process revolves around the intermediate image carrier (a plate) that accepts ink from a roller and transfers it to a rubber blanket. Several types of surface plates are used in lithographic printing: presensitized, electrostatic, photo direct and direct imaged, using a special laser printer.

- Choose plate materials that are compatible with each print job but do not cost extra for characteristics that will not be used.
- Choose coating material that is nonhazardous and can be developed using nonhazardous materials.
- Use two-sided plates.
- Work with the product supplier to find an acceptable alternative to etched plates. If an alternative in not available, recycle chemistry form processing etched plates.
- Use pre-sensitized lithographic plates, water-developed plates, or thermal plates.
- Utilize computer-to-plate technology.
- Recycle/reclaim plates.

6.5.3 Press

6.5.3.a Makeready

Makeready is the procedure in which all the adjustments are made on the press to achieve a reproduction acceptable to the pressperson or customer's representative. This step may be the major source of waste from the printer's point of view. Makeready times can last from a few minutes to many hours. Makeready can be conducted at low speeds or at press production speeds. The printer's objective is to minimize both the time involved in makeready and the number of waste sheets coming off the press. The major wastes associated with makeready are paper and air emissions.

- Use both sides of your makeready paper to cut the amount used in half.
- Save even more by using makeready sheets after both sides have been printed. A clean sheet is inserted every 10th to 100th sheet. The clean sheet is used to check print quality while the other sheets serve to keep the press running.

6.5.3.b Printing Inks

Lithographic inks are oil-based, allowing them to resist the fountain/water attracting portions of the lithographic plate and maintain the plate image. Traditionally, ink oils have been petroleum-based, but ink manufacturers are continually developing inks that substitute much of the petroleum oil with vegetable-based oils such as soybean oil. The oil base or "vehicle" portion of the ink serves to transport and bind pigments in the ink to the substrate.

Prior to the mid-1970's, pigment relied heavily on inorganic metals to provide ink color. These metals were often present in amounts exceeding state and federal regulatory limits, rendering waste ink hazardous. In response, ink manufacturers developed organic coloring replacements, many of which were not as heavily regulated as the earlier metal compounds. Some of the new pigments, however, were manufactured from derivatives of benzene and continued to contain metals. An early 1990s study still detected the presence of heavy metals in some lithographic inks. Other ink additives include solvents, varnishes, and dryers of various kinds. All of these additives are used to control the ink flow characteristics preventing pigment flocculation and to accelerate drying.

Successful lithographic printing, using both traditional dampening processes and waterless technologies, requires the press operator to be a skilled craftsperson knowledgeable about chemistry. Lithographic ink, fountain solution, water, substrate, and press adjustment all play roles in achieving the proper image. Fine tuning the balance among these elements allows the press operator to produce sellable products. Inks are perhaps the most important aspect of the overall lithographic process because the components of different formulations impart different characteristics to the ink, therefore affecting its performance in relationship to the other press elements.

6.5.3.c Ingredients

Today, ink manufacturers are responding to printers' regulatory and process needs by pursuing development of less hazardous or nonhazardous inks that do not compromise printed product quality. With one million new ink formulations released each year, it is impossible to list every ingredient used in every printing ink. It is the responsibility of shop owners to determine whether the inks used in their operations are hazardous. For assistance in making this determination, review your ink container labels, ink Material Safety Data Sheets (MSDS), or ask your ink distributor, and compare the components with the table found on page 6-27 (which lists some of the common ingredients in printing inks, bolding the ones most likely to be regulated by state and federal environmental, health, and safety laws) or see the Michigan Great Printers Project's *"Understanding Hazardous Waste Generation and Responsibilities – An Introductory Guide for Lithographic Printers*."

6.5.3.d Regulations

Printing inks can contain material that makes them toxic and renders wastes hazardous. The need for special handling or specific tests can be determined by examining the MSDSs supplied by ink vendors, which list toxic and potentially hazardous ingredients. Environmental concerns over waste ink center around heavy metals, solvents, and toxicity. If an ink contains color pigments with toxic heavy metals such as barium, cadmium, chromium, or lead, or if the ink is mixed with solvents classified as hazardous wastes, it must be disposed of as a hazardous waste. Some solvents in inks are toxic and/or flammable, and almost all are classified as VOCs, which are regulated under the ***Clean Air Act Amendments of 1990***. VOCs readily evaporate, and once in the atmosphere may be hazardous to your employees' health. For printers faced with controlling VOC emissions from their operations, ink choice can increase or reduce emissions. Proper disposal of ink wastes can be expensive, but is necessary to meet compliance requirements, and just as important, to minimize liabilities faced by a printer.

6.5.3.e Ink Wastes

Color changes, press cleaning and poor ink management (such as drying and excess skinning) generate waste ink. Careful attention to good operating practices, process changes and product substitutions can decrease income losses associated with ink waste.

Printing Ink Constituents and Potentially Regulated Constituents

Vehicles/Varnishes	Commonly Used Chemical Formulations
Rosin esthers	**Rosin and pentaerythritol**
Long-oil alkyd	Phthalic anhydrite and glycerol
Phenolic resin	Phenol and formaldehyde
Hydrocarbon resins	**Ethylene, butadiene and indine**
Modified resin	Maleic acid and maleic anhydride
Waxes	Natural and synthetic
Mineral Oils	Natural and synthetic
Soya/vegetable	Linseed, tall, soybean and safflower oils
Resin/solvent varnishes	**Variety of hydrocarbon solvents**
Drying oils	Alkyd, urethanes and phenolic resins
Pigments	
Organic Pigments:	
Carbon black	Graphite
Organically derived pigments:	**Benzene, Napthalene and Authracene derivatives**
Rhodamines	
AZO pigments	
Inorganic Pigments:	
Cyan blue and green shade cyan	**Copper Phthalocyannine**
Whites	Calcium carbonates, clays and titanium dioxide
Yellows	**Lead, chromium**
Reds	**Barium**
Solvents	
Aliphatic hydrocarbons	**Parafins**
Aromatic hydrocarbons	**Benzene**
Alicyclic hydrocarbons	**Cycloparafins, terpenes**
Co-solvent mixtures	**Alcohols and hydrocarbons**

Bolded constituents may be regulated depending on concentration and overall volume of wastes. Further, some constituents may be regulated more heavily in one state and not another. Check with your state environmental compliance office or technical assistance center for more information.

*Information for this figure derived from Chemistry For The Graphic Arts, Ellred, 1992. Environmental Law Index to Chemicals.

i) *Operating Practices*

Good operating practices like inventory control and careful job management are often the most cost-effective way to decrease the amount of waste ink generated. Most good operating practices focus on wise raw material management and careful pre-thinking prior to running print jobs, so work is accomplished with a low margin of error, thus decreasing waste generation.

- Keep ink containers sealed and contents leveled; place plastic or waxed paper on top of the ink to prevent oxidation.
- Try not to insert the knife into the ink or leave crevices (i.e. reduce surface area to oxidize).
- Scrape as much ink from empty cans as possible prior to disposal or recycling of ink tins.

- Minimize additions to ink fountains.

- Dedicate presses to specific colors or special inks, if possible, to decrease the number of leanings required for each press.

- Use a standard ink sequence for process colors.

- Schedule print runs from lighter to darker colors to decease the amount of cleaning required.

- Recycle light colors into darker and specialty colors.

- Print internal forms with excess ink or donate excess ink to schools.

- Improve accuracy in job estimation.

- Segregate waste ink colors for recycling.

- Carefully monitor inventory to assure that older inks are used in a timely fashion and inks are only ordered if necessary.

- "Prethink" printing jobs and counsel customers about the environmental impacts associated with particular color, paper, or printing method choices. Make sure that print jobs reflect the true cost of doing business and disposing of hazardous wastes.

ii) *Process Changes*

Process changes can decrease the amount of waste ink generated but usually require some equipment purchases and employee training. Process changes can be as simple as installing an ink agitator on the ink fountain to prevent skinning or as complicated as implementing an in-house ink recycling system. Process changes include:

- Install an ink agitator or an ink leveler on the ink tray to prevent premature ink oxidation.

- Recycle waste inks in house or through an ink recycling service.

- Use a computer controlled mixing program and a digital scale for mixing PMT colors. These programs allow print shops to custom mix any ink color from colors already in inventory. This decreases the purchase costs of new colors and increases the use of existing inventory. A digital scale makes the entire process more accurate and decreases the amount of ink wasted as a result of poor estimating techniques.

- Use an anti-oxidant spray to prevent ink skinning in the fountain.

- Use nonskinning inks.

iii) *Mixing Systems*

Ink mixing systems improve press operators' ability to estimate ink needs as well as inventory control. Many printers have been successful in reducing the amount of waste generated by recycling it on site or by contracting with a recycling service to blend it into darker colors for reuse. Whether ink can be reused or recycled is dependent upon the quality of the ink waste that is generated. Waste ink can typically be classified in one of the following two categories:

- Uncontaminated, excess ink – this includes ink that has not bee used in the press fountain. Although is can be recycled, reuse of this ink is usually a more cost-effective means of managing it; or

- Contaminated, combined ink – this ink has been used in the press fountain and is commonly contaminated with paper fibers, solvents, or other colors of ink. For these inks to be recycled, they typically must be filtered, reconditioned and reblended.

iv) *Ink Recycling*

Commercial ink recyclers take waste inks and reprocess them, along with necessary additives, to make recycled ink. The following ink recyclers serve printers located throughout the United States and Canada. Most of these companies offer recycling services for both heatset and non-heatset inks from web presses. Economies of scale associated with ink volumes affect the feasibility of recycling. Therefore, accumulating a large quantify of waste ink reduces the cost of recycling the ink on a per pound or per drum basis. However, as demand increases, and the technology for processing sheetfed ink improves, it is likely that the availability and affordability of sheetfed ink recycling will increase.

3R Corporation
800 Vinial Street
Pittsburg, PA 15212
412-323-1733
Sheetfed recycled into heatset web ink

Envirecycle Ink Recovery
610 Kasota Avenue
Minneapolis, MN 55416
612-379-7500
Sheetfed recycled into sheetfed ink

Lithographic Ink Reformulating Technology, Inc.
3021 Old Maryville Pike
Knoxville, TN 37920
520-577-7966
Sheetfed recycled into sheetfed ink

Pro Active Recycling
908 Niagra Falls Boulevard
N. Tonawanda, NY 14120-2060
519-371-6511 Toll free 888-607-2465
Web heatset and non-heatset

Worldwide Environmental Systems (WECORP)
112 Bedford Road., Suite 116
Bedford, TX 76022
817-590-2936 Toll free 888-588-7828
Heatset and non-heatset litho

Ink Reclamation Systems

Semler Industries, Inc.
3800 North Carnation
Franklin Park, IL 60131
708-671-5650
Lithographic and flexographic filtration equipment

Separation Technologies, Inc.
740-H S Van Buren Street
Placentia, CA 92670
714-632-1306
Lithographic equipment for on-site recycling

Ink Reblending

Mixmasters, Inc.
11 Colmer Road
Lynn, MA 01904
800-332-9321
Software to guide reblending

Note: The above list of ink recyclers is provided solely as a service to printers desiring more information about recycling lithographic inks. The information is voluntarily supplied and alphabetical. It is not necessarily a complete list of available services or suppliers and does not represent an endorsement by MDEQ or the Michigan Great Printers Project (MI-GPP). MDEQ and MI-GPP, by providing this list, do not represent that the companies listed are or are not in compliance with applicable laws. All users of this list are responsible for insuring that any company with whom they contract for products or services are in compliance with the requirements of state and federal law.

v) *Material Substitutions*

Many lithographers have successfully substituted petroleum-based inks with soy/vegetable, ultraviolet (UV) curable, electron beam curable (EBC), high solids and waterless inks to decrease toxicity and VOC emissions as well as achieve desired print effect using less material. Material substitutions generally include using:

- Vegetable/soy inks – these inks provide environmental benefits of low VOC content, reduced dependence on petroleum products and the use of a sustainable resource. The composition of soy ink depends on its use with a certain percentage of the oil being derived from petroleum. Pigments are similar to conventional petroleum based inks and are usually petrochemical derivatives.

  Benefits of soy oil-based inks are: VOC emissions into the atmospheres can be reduced on heatset presses because the VOC content of soy oil-based ink is potentially lower than traditional petroleum based inks (based on the percentage of soy oil in the ink); press washes for soy oil-based inks can be water/detergent types, thus reducing or eliminating the need for high VOC solvent formulations; less paper waste from quicker start-ups, as water and ink balance is reached more easily; spoilage during runs from color or variation

in tracking is minimized; and quicker and more even ink coverage to the press blanket is achieved. In addition, soy oil-based inks have exceptional transfer properties, minimizing plate scumming. Brighter colors and darker blacks are produced, because soy oil-based inks have greater color retention than do traditional petroleum-based inks. The disadvantages are: longer drying time, ink sitting up on the paper, cost, and substituting other chemicals for the petroleum-based ink processes requires operator adjustment and training.

- UV Curable Inks – UV systems consist of a photo-polymerization process that uses mercury vapor lamps for UV photoinitiated monomer inks. UV curable inks are used primarily for printing on plastic, vinyl, metal and paper substrate. These inks contain low VOCs and are cured by ultraviolet light-induced polymerization. UV curable inks will not dry on a press or in ink fountains so there is a decrease in both press cleaning time and waste ink generation.

  The reported advantages of UV curables include: decreased or eliminated VOC emissions, less frequent press cleaning and associated solvent use, reduction in required floor space (eliminated need for drying oven or racks), increased throughput, elimination of ventilated storage of sheets during oxidative drying, and can be used on web as well as sheetfed presses. On the negative side, these inks cost up to twice as much as traditional inks on a per pound basis, a significant capital investment is needed for conversion to UV systems, recycling problems may be encountered with substrate printed with these inks, and potential worker health and safety issues with exposure to X-ray radiation.

- EBC Inks – EBC inks consist of low-molecular weight polymers that react with a stream of electrons from a vacuum tube. These inks contain no solvents, and do not cure until exposed to light and may, therefore, remain in ink fountains for long periods of time, reducing clean-up needs. The electrons drive the reaction, forming polymers and setting the ink.

  Problems reported with EBC inks include paper degradation and worker exposure to X-ray. Electron beam dryers use polymerization by electron bombardment to dry liquid and powdered coatings. These dryers have high initial costs and low to moderate operating costs. They are sometimes used for higher gloss coatings and metal decorating applications.

- Waterless Inks – these inks are high viscosity inks with characteristics similar to petroleum-based inks. The major difference in these ink systems is a resin which produces high viscosity but requires exact temperature controls. The temperature must be controlled with a three stage refrigeration unit. A waterless system requires a high initial capital investment and careful monitoring during operations. Special lithographic presses or re-fitted presses are needed to run waterless inks and special plates, exposure methods, and plate handling techniques need to be employed when waterless inks are used.

Waterless inks are high in solids and are designed to function with a silicon-based lithographic plate. They are not necessarily less toxic or hazardous than other ink types, but the waterless printing system as a whole generates considerably less VOC emissions than traditional lithographic processes.

6.5.3.f Fountain Solution

Fountain solution contains water, isopropyl alcohol (IPA), gum arabic, and phosphoric acid, all of which end up on the paper or evaporate; they do not become hazardous waste. The evaporation of the IPA, however, may create an emission problem and, therefore, be hazardous to shop employees. IPA in fountain solution is used as a wetting agent and allows a broader “operating window” at the press. This broader “operating window” reduces surface tension and leads to easier press control, more even dampening of the form roller, faster evaporation, and reduced ink emulsification. The result is less dampening solution is used and less paper, ink, and time are wasted. Lithographers use alcohol in concentrations up to 35 percent, with most presses ranging from 15-20 percent.

As a VOC, IPA is regulated because it leads to the creation of ground-level ozone by reacting with nitrogen oxides in sunlight. IPA is also flammable. Alcohol substitution can lead to:

- Richer, brighter colors.
- Less replenisher being needed.
- Improved dot quality.
- Greater cost savings.
- Reduced shop odors.
- Reduced fire risk.
- Reduced fountain solution.
- Reduced fugitive VOC emissions, because less of the substitute or fountain solution is used and does not evaporate as readily.

Alcohol substitutes are composed of glycols, such as ethylene glycol, glycol ethers, cellosolve ethers or proprietary compounds. These substitutes reduce the surface tension of the fountain solution but have a more complex chemical structure and higher boiling point than IPA-containing dampeners. To achieve the best print quality without relying on IPA, several factors must be monitored and adjusted to accommodate the different fountain solution properties. These include water quality, fountain solution temperature, pH and conductivity and press roller setting and hardness.

Considerations for switching to a No/Low Alcohol Fountain Solution

⇒ **pH**
- indicates relative acidity (<7) or alkalinity (>7);
- most fountain solutions are acidic, but alkaline and neutral are also used;
- pH is typically measured with a pH pen;
- test strips can be used, but are less accurate;

⇒ **conductivity**
- indicates ability of solution to transmit an electrical charge and is proportional to the ionic concentration in the solution;
- rises as additives or impurities increase in the fountain solution;
- measure this characteristic with a conductivity meter and chart a calibration curve to establish the optimum conductivity range for quality printing;

⇒ **monitor and control fountain solution quality**
- measure the pH and conductivity at least daily;
- during a run, pH can either increase or decrease, depending on acidity or alkalinity of paper;
- contaminants will increase conductivity;

⇒ **monitor and control quality of makeup water**
- inconsistent water quality can affect fountain solution and press performance;
- water needs to have consistent, acceptable pH and conductivity;
- may need to treat incoming water with water softening, deionization, and/or reverse osmosis; and
- before investing in treatment, test treated samples of presses.

Automatic mixing systems, foam-free recirculating systems, refrigeration units, or filters placed on recirculating units can all help to extend fountain solutions. The need for fountain solutions can be eliminated by using “waterless” plates.

6.5.3.g Paper

- Find ways to use scrap paper inhouse. Make notepads, poster paper, or other products from extra paper.

- Recycle all paper stock, including office paper. This saves landfill space and money in disposal costs, and may generate income.

- Separate printed and unprinted paper. Unprinted paper has a higher recycling value than printed paper.

- Donate reusable paper to local organizations (day care, Sunday school, etc.).

- Complete the recycling loop by purchasing paper with recycled content. Look for the highest post-consumer recycled content and the lowest bond weight that your printing requirements and customer stipulations allow.

- Encourage customers to avoid bright colored paper when possible, since it is more difficult to recycle and, therefore, has less recycling value.

- Recycle all skid wrappers, rolls, and cardboard.

Tips for Printing on Recycled Stock

Prepress

- Pinch back dots in the shadow and midtone areas after the correct color is obtained to limit dot gain
- For halftones and separations use a 133-line dot screen
- When printing on colored stock, better separation results can be achieved by using gray component replacement (GCR) and unsharp masking (USM)

During the Press Run

- Always inspect paper stocks upon delivery for correct weight, color, consistency, etc.
- Paper lifts should be wiped down with glycerine to eliminate excess paper-dust
- Pass sheets through press without water or ink to dust them, eliminating loose paper particles
- Slow press runs slightly to eliminate picking or linting
- Reduce the ink tack slightly
- Print two “hits” of a solid to reduce picking
- Allow more drying time and use smaller stacks of paper
- Run sheet grain parallel to press cylinders to avoid sheet spread
- Run slightly more water or alcohol on uncoated sheets but be careful to avoid too wet a run which can lead to ghosting

*Excerpted from “Helpful Hints for Printing on Recycled Uncoated Papers,” 1993 Cross Pointe Paper Corporation, St. Paul, MN

6.5.3.h Blanket Washes

Offset presses utilized in the industry transfer the printed image from a plate to a rubber or plastic blanket and then to the paper or other medium being used. The cleanliness of the blanket is a primary concern for producing high quality images. Blanket washes, consisting of varying types of solvents, are employed in removing ink, paper dust, and other debris from the blanket cylinder. Traditionally, blanket washes were petroleum-based solvents with a VOC content of greater than 60 percent. While these high VOC washes leave the blanket dry after cleaning, the quick-drying properties come from the VOCs that evaporate into the air where they may pose a potential risk to human health and the environment. VOCs can also have an adverse impact on surrounding area air quality because of their contribution to the formation of ground level ozone. Allocating time for employees to experiment with substitute cleaners and creating press procedures that use low VOC cleaners is an investment in reducing control technology costs to meet air emission standards. Feedback from employees and constructive suggestions help create and effective pollution prevention program.

The formulations for low VOC blanket and roller washes have been constantly changing. Many contain naptha, aromatic and aliphatic hydrocarbons, inorganic phosphates, and proprietary compounds. All of these compounds have a variety of negative health and environmental impacts. Many formulations are totally proprietary and their ingredients are not listed. Contact

press cleaner manufacturers to discuss your cleaning needs and environmental benefits of their products. When making evaluations consider ink, paper, fountain solution, and the type of press. If a product sounds promising, request a sample if a return policy exists. Many manufacturers provide technical assistance to ensure successful product use.

When selecting a new product, determine the specific pollution prevention goals (i.e. reduce VOC emissions, reduce worker contact with solvents that cause dermatitis, make shop towels acceptable to laundry service, eliminate wastewater) you wish to attain. Review the product's MSDS for hazardous constituents (i.e. naptha or 1,2,4 tri-methylbenzene); the flashpoint (if less than 140^0 F the material becomes an ignitable hazardous waste when discarded); and the VOC content either expressed as a percent (preferably less than 30) or in pounds of VOC per gallon of solution.

Testing of low VOC blanket washes in commercial printing facilities was conducted by the U.S. Environmental Protection Agency's (USEPA) *"Design for the Environment"* (USEPA, Oct. 1996, *Vegetable Ester Blanket Wash*). The USEPA concluded that more effort, both mechanical and in the number of steps, is needed to get the blanket clean. The substitute washes will work well if the application method is modified to enhance the cleaner's performance. The report suggested that if the first low VOC blanket wash does not work well, try another.

To ensure successful testing of alternative cleaners, follow manufacturer's cleaning directions for new products. If the products are not used as intended, more will be needed to clean the press. Low VOC cleaners tend to be water-soluble or water-miscible and often require a water rinse following cleaner application. Although this may take more time than traditional cleaners, the rinse also removes paper dust and lint. Manufacturers are incorporating the best management practices into their directions of use as more research and experience is available.

When considering product substitution, suppliers can be a valuable source of information and should be able to provide you with the information required to make an informed choice. Contact the supplier and the manufacturer for information on potential health and environmental effect on the process, use and disposal of cleaners. The USEPA has developed a list of questions to help lithographers obtain the information they need:

What chemicals are in the blanket wash? Request an MSDS and ask what chemicals are in the wash that are not included on the MSDS. Are there any **hazardous air pollutants (Clean Air Act)** contained in the wash? Are any extremely hazardous substances contained within the blanket wash?

What is the VOC content and vapor pressure of the wash? This information is typically included on the MSDS. Ask how the VOC content is calculated. Also, if the wash is mixed on-site with other solvents or water, the VOC content of the cleaner when ready for use should be recalculated to accurately determine worker exposure and potential emissions.

What health risks are associated with the use of the blanket wash? Ask what type of particular ventilation is needed. What types of short-term symptoms might an employee experience from daily use of the product? Are there any long-term effects?

Should dermal protection be worn when using the wash? The MSDS sheet should provide recommendations for personal protection equipment when using the product.

What are the best ways to use the wash to minimize both human and environmental exposure?

How should the blanket wash be used to make this product work best?

What is the proper method for disposing of the used blanket wash and shop towels?

Are there any ingredients that will be RCRA, state, or locally regulated when used as a cleaner?

Will used shop towels or used blanket wash be considered hazardous waste under RCRA?

Are there any special precautions when laundering used shop towels?

USEPA research has demonstrated successful substitution of low VOC cleaners using an integrated approach. Cleaning equipment, targeted product substitution, and changing operator practices can reduce VOC emissions from cleaners. Currently, options for substitute blanket washes include petroleum-based cleaners, vegetable ester cleaners, petroleum/vegetable ester mixture, and terpenes. The table found on page 6-37 provides a quick checklist of pluses and minuses for these substitute blanket washes and was taken from the USEPA *"Design for the Environment," Vegetable Ester Blanket Wash* summary.

Characteristics of Each Group of Blanket Washes	
Naptha	+ quick drying - VOC content 100% - negative health risk
Petroleum-based	+ quick drying - VOC contents up to 60% - negative health risk
Vegetable esters	+ low VOC (as low as 5%) + shop towels not hazardous + no odors - slow to dry
Terpenes	+ low VOC + not ozone depleting - irritating odors
Vegetable esters/ Petroleum mixes	+/- less than petroleum-based washes but not all are < 30% +/- may have some health risks based on the proportion of petroleum products

6.5.3.i Lubricants

No matter what part of a company's operating budget lubricants represent, their effect on overall costs and productivity can be substantial, especially considering they may have to be managed as hazardous wastes when they have no further use. A good lubricant management system and machine maintenance program extend the useful life of lubricants and have both economic and environmental advantages:

- Provide repeatability and quality for machine operation; i.e., printing presses and bindery processes.
- Decrease costs of disposal for waste lubricant.
- Decrease purchase costs of lubricants.
- Lessen machine downtime.
- Provide a cleaner work environment and improved health conditions.

Equipment lubricants (including semi-solid greases) are an extremely diverse group. Because of the diversity, it is crucial to follow machine manufacturers' recommendations when selecting equipment lubricants. This, however, is only a starting point. With a solid machine maintenance system in place, and with careful and detailed records, the cost benefits of selected lubricants can be maximized. Note that it is not just the cost of the lubricant that must be considered—all related costs must be considered as well. These costs include the cost of the lubricant, the cost of changing or adding lubricant, machine wear characteristics, and downtime of production.

i) *Reduction of Use*
The easiest step to reduce unnecessary lubricant use and the subsequent disposal of used products is to accurately determine the minimum amount of lubrication that will satisfy equipment need. This will be determined by using equipment manufacturer recommendations and both careful review of maintenance records. Also, careful control of inventory can be a substantial benefit, assuring that lubricants are not subject to deterioration or obsolescence.

ii) *Substitution*
Make sure that substitute lubricants are really an advantage. Check with the equipment manufacturer to verify that the substitute lubricant is suitable for use in the particular equipment application. For example, synthetic lubricants may last longer and, therefore, eliminate some costs of maintaining the equipment, including down time and frequency of service. The initial cost of a lubricant, while potentially higher, may result in an overall savings once all factors are considered.

iii) *Reclaiming Waste Lubricants*
There are two primary ways to reclaim used or waste lubricants:

- Reclamation on the use site.
- Use of reclamation services.

The decision depends on the needs and cost factors. In general, if the volume of used lubricants is relatively small, the capital expense of putting in a reclamation system may be prohibitive.

If the volume of used lubricants is large, however, installing a reclaim system is likely to be cost justified, with substantial savings. Keeping control of the used/waste lubricants assures that the reclaimed material will be put back into service with the specified characteristics required for the particular machinery.

One (nonprinting) company reported a 90 percent reclamation for reuse of waste oil by means of a distillation and filtration system. The system draws oil by vacuum from waste oil tanks, through a prefilter, an adjustable flow control valve, and through an electric heater into a vaporizer. The moisture and dissolved gases are drawn off in the form of a vapor. The vapor is condensed and collected for disposal. The purified oil is pumped through a polishing filter and collected for reuse. Although capital cost was $20,500, the system reduced virgin oil requirements and reduced waste oil disposal volume, making the project cost justifiable.

6.5.4 Post-Press

6.5.4.a Finishing

The final steps in making a printed product may include cutting, folding, assembling, binding, and laminating. Typical waste streams are scrap paper from trimming, rejects from finishing operations, and VOCs from the adhesives used in binding and other assembly operations. P2 opportunities include:

- Determine which paper (types and weights) and inks run best in the plant by reviewing past jobs. Label selected materials as “house” stocks and carry them in larger inventories offering price incentives and quicker delivery times for use of these materials.
- Reduce paper use by selecting properly sized paper and recycle waste paper and cardboard.
- Replace VOC-based adhesives with water-based adhesives, hot-melt adhesives, or mechanical methods in binding operations.
- Transition to water-based coatings.
- Choose finishing materials that can be recycled.
- Evaluate/install computer-controlled in-line finishing systems that directly link the press with post press operations.
- Use pressroom rejects or makeready sheets for setting up cutters, folders and binders.
- For repeat jobs, keep a record of cutter and folder setup positions.

6.6 Where To Go For Help

SUBJECT	**Michigan Great Printers Project**
CONTACT	DEQ, Environmental Science and Services Division
TELEPHONE	(800) 662-9278
WEB SITE	**www.michigan.gov/deq -** Select "Pollution Prevention" "Business Partnerships" "Great Printers"
PUBLICATIONS	1. Becoming a Great Printer 2. Case Study: McNaughton & Gunn, Inc. 3. Case Study: Mitchell Graphics 4. MI-GPP Printing Industry Resource List 5. Pollution Prevention Checklist and Strategies for the Printing Industry 6. Regulatory Guidebook for Michigan's Lithographic Printing Industry, Version 1 7. Small Business Pollution Prevention Loan Program and the MI-GPP 8. Understanding Hazardous Waste Generation in the Printing Industry 9. Working With Your Supplier
SUBJECT	**Retired Engineer Technical Assistance Program (RETAP)**
CONTACT	DEQ, Environmental Science and Services Division
TELEPHONE	(800) 662-9278
WEB SITE	**www.michigan.gov/deq** - Select "Assistance & Support Services" "Technical Assistance" "RETAP"
PUBLICATIONS	1. Case Study: West Michigan Uniform, Inc. – Laundering company implements waste reduction 2. Case Study: The Bohning Company, Ltd. – A RETAP Success Story 3. Case Study: MacDermid, Inc. – A chemical manufacturer improves efficiency through water use reduction 4. Case Study: Shane Steel Processing, Inc. – Reduces waste 5. RETAP Brochure 6. RETAP Fact Sheet
SUBJECT	**Pollution Prevention for the Printing Industry**
CONTACT	U.S. Environmental Protection Agency – Design for the Environment, Lithographic Printing Partnership
WEB SITE	**www.epa.gov/dfe/projects/litho/index.htm**
PUBLICATIONS	1. Cleaner Technologies Substitutes Assessment: Lithographic Blanket Washes 2. DFE Lithography Project CTSA Summary Booklet – Solutions for Lithographic Printers: An Evaluation of Substitute Blanket Washes 3. Federal Environmental Regulations Potentially Affecting the Commercial Printing Industry 4. Lithography Project Bulletin #1: Substitute Blanket Washes – Making Them Work 5. Lithography Project Bulletin #2: Workplace Practices Make the Difference 6. Lithography Project Bulletin #3: Vegetable Ester Blanket Washes 7. Lithography Project Bulletin #4: A Worksheet to Help You Choose a Better Blanket Wash 8. Lithography Project Case Study #1: Managing Solvents and Wipes 9. Lithography Project Case Study #2: Pollution Prevention at Custom Print 10. Lithography Project Fact Sheet: Blanket Wash Solutions for Small Printers 11. Lithography Project Publications List 12. Printing Industry and Use Cluster Profile 13. Summary of Focus Group Discussions with Screen Printers and Lithographers for the Design for the Environment Printing Project